The Role of Organic Sea Salt Aerosol in Cloud Processing

Lynn M. Russell
Department of Chemical Engineering
Princeton University
Princeton, NJ 08544
phone: (609) 258-1144 fax: (609) 258-0211 email: lrussell@princeton.edu

Award #: N00014-98-1-0565
http://www.princeton.edu/~aerosol/

LONG-TERM GOAL

My long term goal is to quantify the role of organic compounds in sea salt aerosol. This project studies the effect of organic compounds on the uptake of water by sea salt aerosol particles. Studying the chemical composition of those particles provides important information about their behavior in the atmosphere.

OBJECTIVES

I want to know what role the presence of organic species may play in the hygroscopicity of particles. In particular, I want to know how the organic composition of particles affects their ability to take up water in subsaturated conditions and to serve as cloud condensation nuclei in supersaturated conditions.

APPROACH

We have studied the empirical relationship between the organic composition of particles and their size. We have constructed a thermodynamic model that accounts for the effect of organic compounds on the uptake of water by particles.

We have developed a method of measuring the organic fraction of particles by FTIR, and we have participated in an airborne field campaign in the Carribean in order to collect airborne measurements of the organic fraction of sea salt particles.

WORK COMPLETED

A model describing the interactions of organic compounds and electrolytes has been constructed and compared to laboratory and experimental measurements. The model has been used to predict the hygroscopic properties of organic-containing sea salt particles.

RESULTS

A thermodynamic model was developed to describe the phase equilbria of electrolyte-organic mixtures in aerosol particles. Three types of contributions to activity coefficients including ion-water,organic-water and ion-organic interactions are accounted for by combining Pitzer equations and the UNIFAC

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 2001		

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The Role of Organic Sea Salt Aerosol in Cloud Processing	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Department of Chemical Engineering,,Princeton University,,Princeton,,NJ, 08544**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT
My long term goal is to quantify the role of organic compounds in sea salt aerosol. This project studies the effect of organic compounds on the uptake of water by sea salt aerosol particles. Studying the chemical composition of those particles provides important information about their behavior in the atmosphere.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**		**4**	

framework into a general model. The model is parameterized by fitting interaction parameters from experimental data collected in the literature. The accuracy of the model predictions compare well with available measurements. The hygroscopic growth curves calculated by the model achieve good agreement with measurements (Cruz and Pandis, 2000; Hameri et al, 2001). The results show that the water uptake by ion-organic mixtures is influenced by the solubility of organic components, as illustrated in Fig.1. The presence of 50% malonic acid in (NH 4)2SO4 reduces the growth by 20%, while a 30% decrease is incurred by 50% succinic acid. The soluble organic components can also decrease the DRH of a pure salt. The model predicts that mixing with 50% malonic acid lowers the DRH of (NH4)2SO4 from 80% to 58%. Comparisons of the growth curves of internally and externally mixed aerosol indicate the impact of mixing states on the hygroscopic properties. For insoluble organic components,there are few differences between growth in internal and external mixtures.

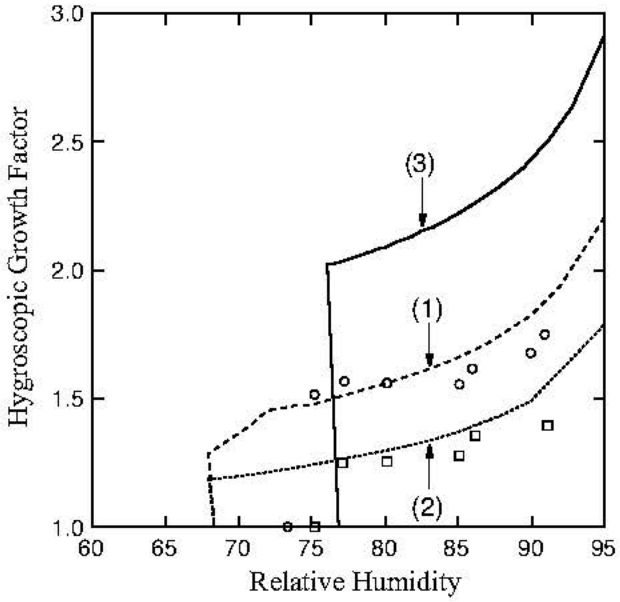

Figure 1. Predicted hygroscopic growth of particles (dry diameter nm) with varying organic compositions. The two compositions studied are (1) 50% NaCl and 50% glutaric acid (model prediction: dashed line; experimental measurements: open circle); (2) 80% NaCl and 20% glutaric acid (model prediction: dotted line; experimental measurements: open square);and (3) 100% NaCl (solid line) is included for reference. Experimental data are from Cruz and Pandis (2000).

IMPACT/APPLICATION

This work has applications for determining the role of organic compounds in aerosol scattering. By assessing the contribution of organic mass to particles in field measurements we will be able to quantify the role of organic species in continentally-influenced aerosol populations.

The organic model has already been used to analyze recent measurements of hygroscopic growth. This application of the model is expected to continue with use by other groups.

TRANSITIONS

We expect that the method we have developed for organic analysis will be used in future field campaigns.

RELATED PROJECTS

1 -- We have started a collaboration with Sonia Kreidenweis to interpret their measurements of hygroscopic growth of organic acids.

REFERENCES

Cruz, C.N., and Pandis, S.N.(2000). Deliquesence and Hygroscopic Growth of Mixed Inorganic – Organic Atmoshperic Aerosol, *Environ. Sci. Technol.* 34:4313-4319.

Hameri, K., Charlson, R.,and Hansson, H.C.(2001).Hygroscopic Properties of Particles Containing Ammonium Sulphate Mixed with Carboxylic Acids, submitted.

PUBLICATIONS

“Predicted Thermodynamic Equilibrium of Aqueous Solutions of Organic Electrolyte Mixtures in Aerosol Particles,” Y. Ming and L.M. Russell, *American Institute of Chemical Engineers Journal*, in review, 2001.